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ABSTRACT

This accident report illustrates and exemplifies three significant safety issues with which the Board has long been concerned: (1) the use of seatbelts by the drivers of schoolbuses, (2) the location and security of schoolbus fuel tanks, and (3) the mode of opening of schoolbus service doors. (Photographs may reproduce poorly.) (Author)

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HIGHWAY ACCIDENT REPORT

SCHOOLBUS/AUTOMOBILE COLLISION AND FIRE,

NEAR RESTON, VIRGINIA

FEBRUARY 29, 1972

ADOPTED: APRIL 12, 1972

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591
REPORT NUMBER: NTSB-HAR-72-2

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15. Supplementary Notes

16. Abstract

At 8:15 a.m., February 29, 1972, a 1961 sedan ran a stop sign at Lawyers Road and Soapstone Drive, in Fairfax County, near Reston, Virginia, collided with a Fairfax County Schoolbus with four children aboard. The impact ruptured the schoolbus fuel tank and knocked it from the bus, and disabled the schoolbus service door. The sedan driver was ejected and seriously burned in the gasoline fire which ensued. The schoolbus ran off the roadway and partially overturned, injuring all occupants, but did not catch fire. The highway, environmental factors, and vehicle condition were not factors in this accident.

The National Transportation Safety Board determines that the probable cause of this collision was the failure of the sedan to yield right-of-way at a stop sign. Fire was caused by undertermined source of ignition of gasoline spilled from the ruptured and detached schoolbus fuel tank, contributed to by the vulnerable location of the fuel tank and the absence of crash-protection design features.

The second collision of the bus, into the embankment, was caused by loss of driver control. The nonuse of available seatbelts by the driver prevented the regaining of control. The injuries to the bus occupants were caused by impact against interior bus components in the second collision and partial overturn.

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FOREWORD

This schoolbus/automobile accident report illustrates and exemplifies three significant safety issues with which the Board has long been concerned. The Board conducted a limited accident investigation in this case, focusing primarily on the facts and analysis pertinent to these issues, which are:

1. The use of seatbelts by the drivers of schoolbuses;

2. The location and security of schoolbus fuel tanks; and

3. The mode of opening of schoolbus service doors.

This report is based entirely upon investigations by the National Transportation Safety Board.

Table of Contents

Part	Subject	Page
	Foreword	iii
I.	Synopsis and Probable Cause	1
II.	Facts	4
	A. The Crash Event	4
	B. The Roadway	4
	C. The Vehicles	5
	D. The Drivers	14
	E. Other Pertinent Facts	15
III.	Analysis	20
	A. Crash Kinematics	20
	B. Use of Seatbelts by Schoolbus Drivers	22
	C. The Location of Schoolbus Fuel Tanks	23
	D. Opening Mode of Schoolbus Service Doors	24
	E. Persons Affected by Schoolbus Safety Issues	25
IV.	Conclusions	26
V.	Probable Cause	28
VI.	Recommendations	29

ILLUSTRATIONS

Figure	Subject	Page
1	Diagram of Accident Scene	2
2	Driver's Seatbelts Wrapped Around Footrest Bar	6
3	Right Side of Schoolbus, Showing Damage	8
4	Service Door of Bus, Showing Damage	9
5	Front End of Schoolbus Fuel Tank	10
6	Rear End of Schoolbus Fuel Tank	11
7	Front of 1961 Chevrolet Impala Sedan	13
8	Universal Location of Schoolbus Fuel Filler Spout	16
9	Location of Schoolbus Fuel Tank	17
10	Split-type Door, Front Half Swinging Outward and Rear Half Swinging Inward	19
11	Sketches Showing Relative Heights of Affected Vehicle Components	21

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HIGHWAY ACCIDENT REPORT

Adopted: April 12, 1972

SCHOOLBUS/AUTOMOBILE COLLISION AND FIRE,
NEAR RESTON, VIRGINIA, FEBRUARY 29, 1972

I. SYNOPSIS AND PROBABLE CAUSE

This accident occurred at the intersection of Lawyers Road and Soapstone Drive, in Fairfax County, near Reston, Virginia, at about 8:15 a.m., February 29, 1972, in clear, dry weather. There were no defects in the highway; visibility at the intersection was fairly good in all directions. No other traffic was present.

A Fairfax County schoolbus, with three special-education students [1/], the female driver, and the driver's 4-year-old son aboard, was westbound on Lawyers Road at about 25 miles per hour (m.p.h.). A 1961 four-door sedan, with male driver only, was southbound on Soapstone Drive, also at about 25 m.p.h. The sedan failed to stop at the clearly visible stop sign and struck the right side of the bus, directly at the service doors, then rotated into the fuel tank area. The impact knocked the fuel tank from the bus, and the spilled gasoline immediately burst into flame. The sedan rotated clockwise about 100° and traveled west about 78 feet, coming to rest 9 feet north of the edge of Lawyers Road in a shallow graded ditch. The detached bus fuel tank traveled essentially parallel to the sedan and came to rest about 10 feet ahead and to the left of the sedan. Fire spread along the roadway and the graded ditch, partly engulfing the sedan. The sedan driver was ejected during its severe clockwise rotation; injuries from ejection were minor, but he suffered second- and third-degree burns over 30 percent of his body. He has not been available for interview because of his injuries.

The schoolbus driver was thrown from her seat toward the right at impact and completely lost control of the bus, which traveled forward and to the left. It crossed a shallow cement-lined drainage ditch and struck a steep dirt embankment, about 140 feet west of the intersection, off the south side of Lawyers Road. With its front axle and springs broken away from the chassis, the bus bounced and slid westward another 25 to 30 feet, overturned onto its right side, returned upright, and came to rest some 175 feet from the point of impact. It did not catch fire. The driver was shaken and bruised; all four children (three students and pre-school son of the driver) were slightly injured--cuts and bruises--during the overturn kinematics. (See Figure 1.)

1/ The elementary-school students were classed as "emotionally disturbed" youngsters, with learning problems; they were not classed as retarded.

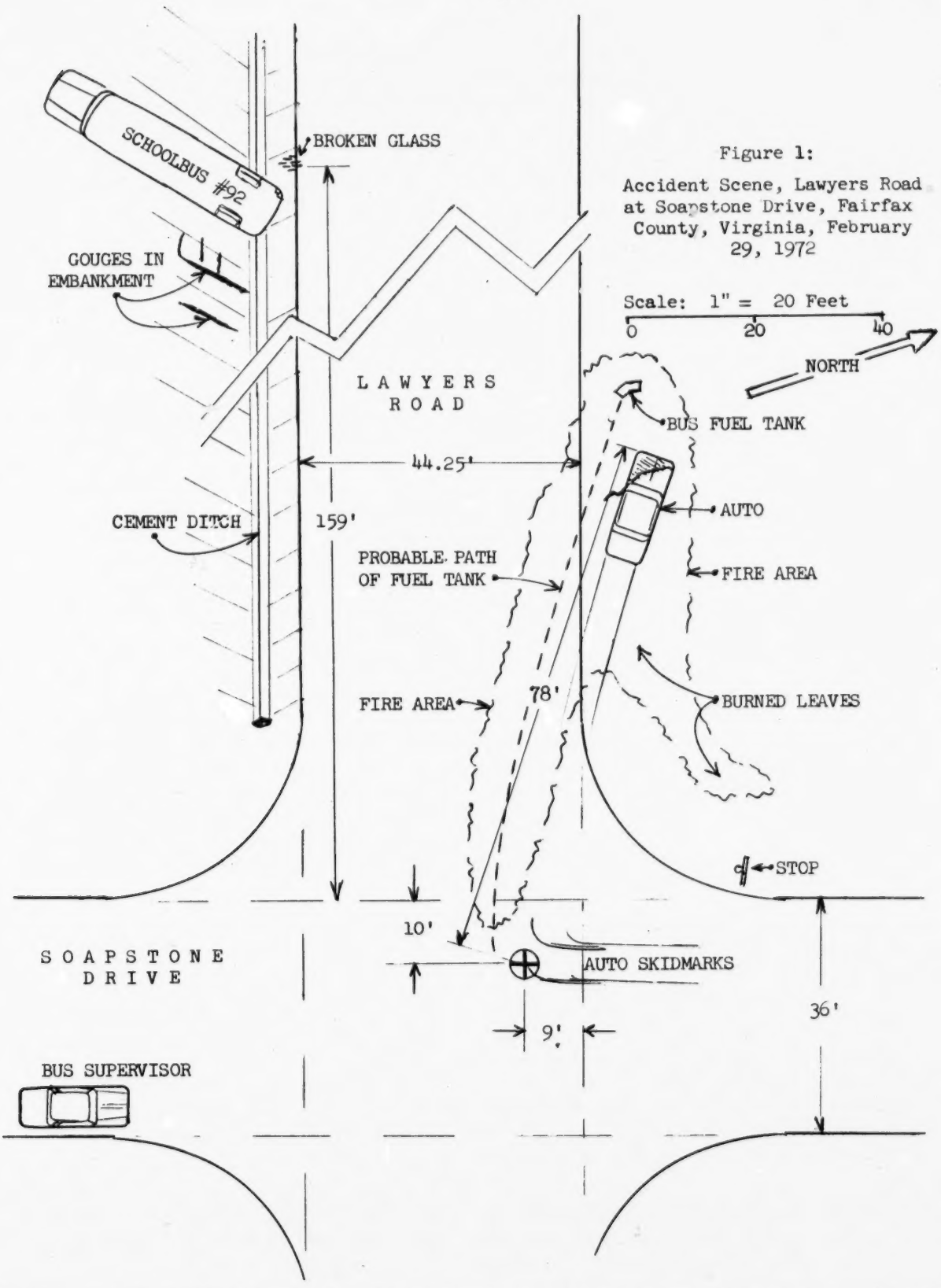


Figure 1:

Accident Scene, Lawyers Road at Soapstone Drive, Fairfax County, Virginia, February 29, 1972

A schoolbus field supervisor had been parked at the intersection to check schoolbus schedule compliance. On witnessing the crash, he radioed for police and ambulance assistance, then rushed to the bus. He could not enter the left-rear emergency door because it was over 6 feet off the ground. He entered the bus via the driver's window and immediately pushed out sections of the windshield, through which the driver and children were evacuated.

The National Transportation Safety Board determines that the probable cause of this collision was the failure of the driver of the sedan to yield right-of-way at a stop sign. Fire was caused by an undetermined source of ignition of gasoline from the ruptured and detached schoolbus fuel tank, contributed to by the vulnerable location of the fuel tank and the absence of crash-protection design features. Injuries to the sedan driver were caused by impact with internal components of the sedan, by ejection onto the roadway, and by exposure to flames from the burning gasoline.

The second collision of the bus, into the embankment, was caused by loss of driver control. The nonuse of available seatbelts by the driver prevented the regaining of control. The injuries to the bus occupants were caused by impact against interior bus components in the second collision and partial overturn.

II. FACTS

A. The Crash Event:

The schoolbus was traveling west on Lawyers Road at a speed of about 25 m.p.h., as stated by the driver and by a schoolbus supervisor who was parked at the intersection making schedule checks of schoolbuses. The bus was nearly through the intersection when it was struck on the right side, just behind the front wheel, by a southbound sedan, which failed to make a stop at the stop sign. The sedan was also going about 25 m.p.h., according to the schoolbus supervisor.

In the crash, the schoolbus driver was thrown to her right, out of the driver's seat. She was not wearing available seatbelts. The bus continued westward on Lawyers Road, with transmission still in gear, and ran off the roadway at an angle onto an embankment on the left (south) side of the road, some 140 feet from the intersection. Striking the embankment, the bus rotated slightly counterclockwise, slid sideward and partly overturned onto its right side. It settled back in a near upright position, with its front end high up the embankment and its right rear on the roadway edge; its left rear was several feet off the ground. It did not catch fire.

The sedan spun clockwise at impact and then moved westward to a point 78 feet west of the point of impact and 9 feet north of the north edge of Lawyers Road, in a shallow ditch area.

The schoolbus fuel tank became detached at impact and was found about 10 feet ahead of, and slightly to the left of, the front of the sedan. According to the schoolbus supervisor, there was a huge flash of fire westward along Lawyers Road immediately after the initial collision, and the driver of the sedan either fell out or was ejected into the fire area.

B. The Roadway

Both roads are of fairly new asphaltic concrete, with graded dirt shoulders about 5 feet wide. Lawyers Road is 44.25 feet wide and has a westbound upgrade of about 3 percent. Soapstone Drive is 36 feet wide, with a southbound upgrade of about 2 percent. There is a 4-foot wide crosswalk across Lawyers Road, just east of the intersection, but no other painted center lines, lane lines, or stop lines. There are stop signs on Soapstone Drive as it intersects Lawyers Road; the southbound stop sign is located 25 feet north of the intersection and 4.5 feet west of the pavement edge. No other traffic controls are present.

A low ditch area lies off the northwest corner of the intersection, bordered by small trees. A cement-lined drainage ditch is located on the south side of Lawyers Road, about 6 feet from the roadway and about 2 feet below the pavement level. A graded embankment rises beyond the ditch; it has a slope of about 30 percent and rises about 8 feet above the pavement, then levels off.

From a point 100 feet east of the intersection on Lawyers Road, traffic on Soapstone Drive can be seen for approximately 100 feet north of the intersection. A small clump of evergreens partially obstructs the view at a mutual distance of about 50 feet from the intersection, but not enough to hide a moving automobile.

The probable point of impact, denoted by pavement scratches and tire marks, and verified by an eyewitness, was 9 feet south of the north boundary of the intersection and 10 feet east of the west boundary.

Two double-ridged skid marks entered the intersection from the north, for an overall distance of 12 feet up to the point of impact, then veered directly westward and curved (and faded) in the direction of where the sedan was found. A second pair of marks, believed to be the rear-wheel skidmarks of the sedan, began at a point 24 feet north of the point of impact and faded into the other two, which were apparently from the front wheels. There were wheelprints in the rain-softened earth leading from the sedan back toward the point of impact. There were no wheel marks, skidmarks, or other surface marks denoting the probable path of the schoolbus after impact. However, its angle and point of impact with the dirt embankment indicated a left curving path of travel after its impact with the sedan.

C. The Vehicles:

1. The schoolbus was a 66-passenger Bluebird body on a 1964 Ford chassis, bearing Virginia license plate 60 (M) 789, Fairfax County No. 92. Its service door was of the split type, with the forward half swinging outward and the rear half swinging inward. Its fuel tank, of approximately 30 gallons capacity, had been mounted 0.65 feet rearward of the doorstep, 1.0 feet in from the body "skirt," with its back against the longitudinal frame rail.[2/] The tank measured 3.3 feet long, 1.425 feet wide, and 0.95 feet high. The bottom of the tank was approximately 1.6 feet above the ground. The filler spout was connected to the exterior filler opening by a flexible hose and short steel neck; the cap was in a recessed area, covered by a spring-loaded flat steel door, about 16 inches back of the passenger service door. Tank venting was through the filler cap only.

In place of the manufacturer's "standard" emergency door, at the back of the bus, Fairfax County had specified that the emergency door be located on the left side, at the extreme rear. All Fairfax County buses are so designed, and have identical three-point lock mechanisms which are openable by intent only.

Driver's seatbelts have been provided for all Fairfax County schoolbuses since 1966, but there was no requirement that drivers use them. In this bus, both ends of the belt were wrapped neatly around a lateral stanchion or footrest behind the driver's seat (See Figure 2).

2/ Measured from a "sister" bus of the same dimensions.

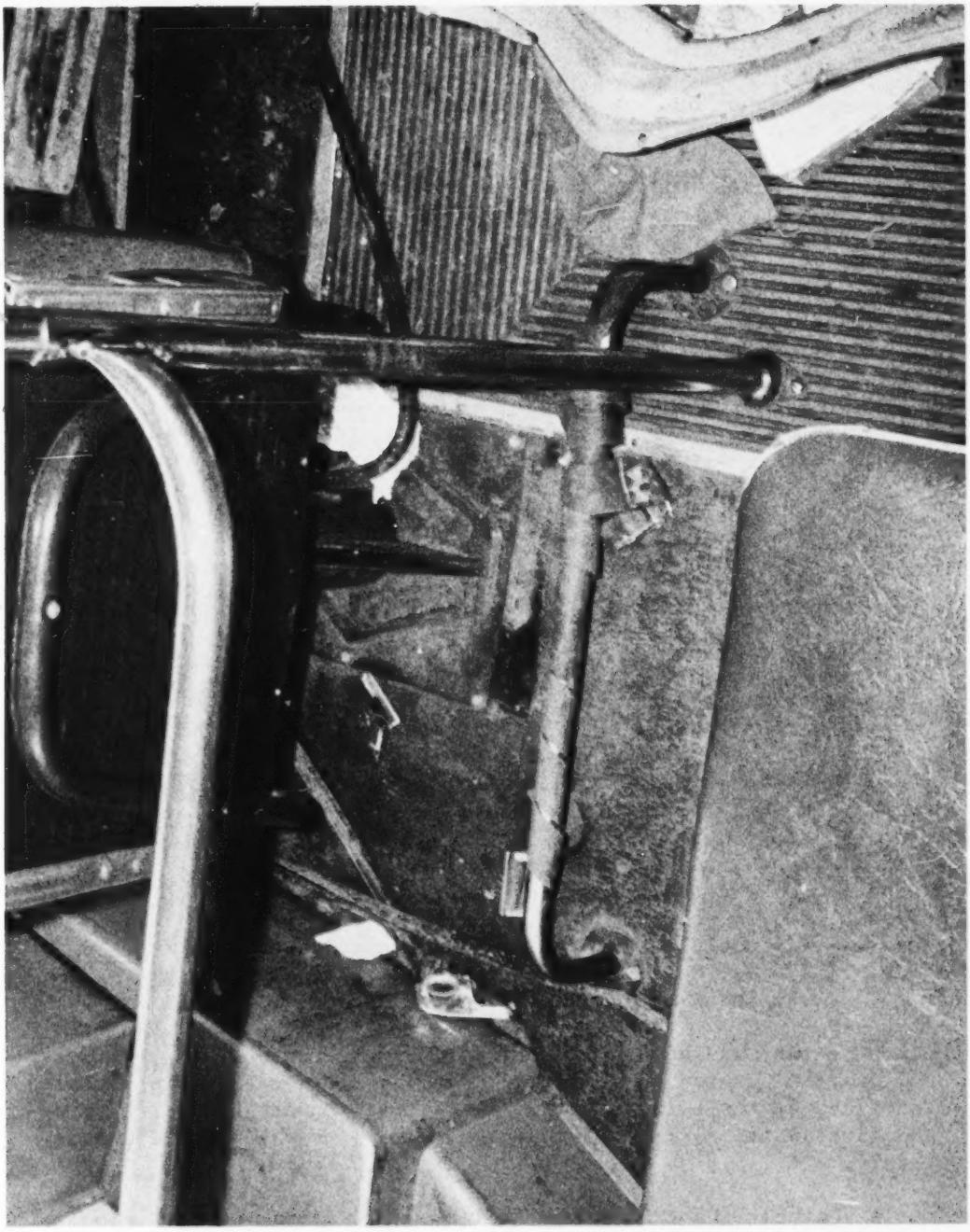


Figure 2: Driver's seatbelts wrapped around footrest bar.

According to the driver, the schoolbus had a general service check about 2 weeks prior to the accident, including an alignment check. She said the bus was in good operating condition. She had filled the tank at a school gasoline facility that morning, and had used about 10 gallons in an earlier high school pickup run and in the outbound portion of the second run; there were about 20 gallons in the tank at the time of the accident, she said. No operational testing of the bus was possible.

Damage to the schoolbus consisted of the following: (See Figure 3, 4).

Front axle and springs torn from chassis; front fenders damaged;

Inward and rearward displacement of body sheetmetal at rear of right front fender and forward part of doorstep;

Bottom doorstep torn from bus;

Both halves of service door bent inward at the bottom, about 1 foot; horizontal score marks at bottom of both doors; lower glass panes broken out;

Inward and rearward bending of entire body skirt, from doorstep area to right rear wheel-well area;

Fuel tank missing (described later), and both hanger straps and brackets broken; fuel intake line (from tank to engine) in place, with fitting torn from tank body;

Metallic scratches and black paint smears along right frame rail, from the normal location of the tank to a point about 8 feet rearward;

Forward half of drive shaft separated from rear half (at U-joint spline);

Right rear corner of bus body damaged, with inward distortion of sheetmetal and absence of rear right window glass;

Windshield (both halves) missing, reportedly pushed out by bus supervisor after the crash;

About 8 or 10 bottom seat cushions out of place.

The bus fuel tank, examined later, showed evidence of fire and of crushing damage as follows (see Figures 5, 6);

A shallow longitudinal indentation along the outer-facing wall;

Figure 3: Right side of schoolbus, showing damage to lower portions of service door and to body skirting.

Figure 4: Service door of bus, showing inward distortion at bottom, loss of lower panes, and diagonal marks from striking the embankment.

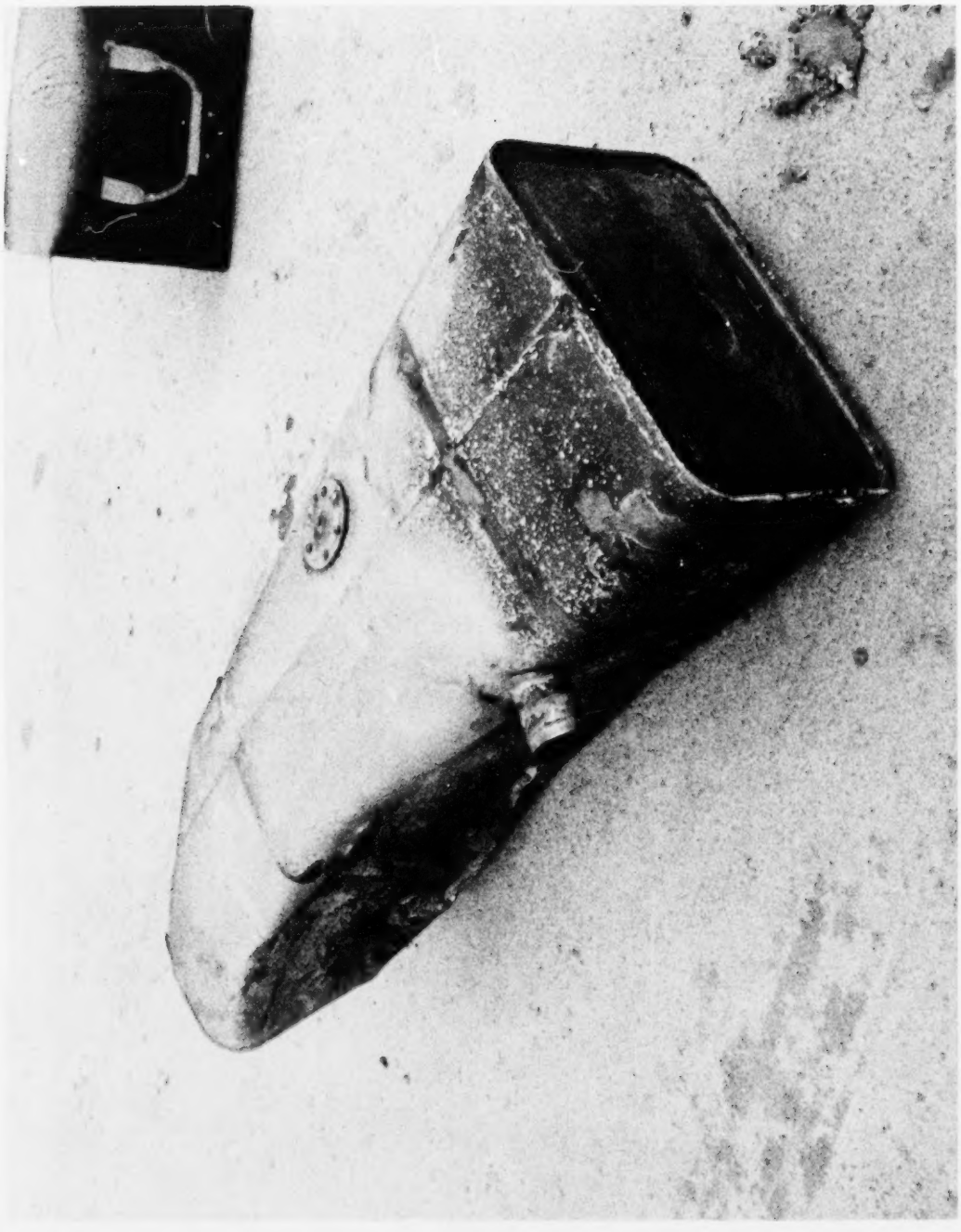


Figure 5: Front end of schoolbus fuel tank. Note inward distortion at the side, rearward of the filler neck.

Figure 6: Rear end of schoolbus fuel tank. Note "L" shaped indentation where tank was pressed against chassis frame, rupture of rear seam, and 3/4-inch hole from fuel line fitting.

The rear tank head crushed inward (toward the chassis frame), with an indentation matching the dimensions of the frame rail imprinted on the inner tank face and rear head;

A 1-foot-long split in the rear seam, opening to about 2 inches wide at its widest point;

A rectangular hole, about 3/4 inch by 2 inches, in the inner-facing tank wall, near the frame rail, about 6 inches from the rear end of the tank;

The flexible connector from tank to filler neck was burned away, with charred fragments adhering to the clamps; and

Fuel-line connector fitting torn from the tank, leaving a 3/4-inch round hole in the top of the tank; the fuel-intake line, normally extending down into the tank, was broken from the fitting.

2. The sedan was a 1961 Chevrolet Impala four-door model, Virginia license 166-246, Serial No. 11869A134372, with off-white repaint over an original off-white finish. Impact damage consisted mainly of the following (see Figure 7).

Front end crushed rearward, with downward distortion of sheetmetal at the grille and hood, with about 26-inch rearward crushing at the left, above the bumper line;

Radiator crushed rearward and downward; battery casing crushed; battery cables jammed between sheetmetal components; forward engine components badly damaged;

Minor indentations to front bumper, with two 1-inch by 3-inch dents on right side; almost no distortion to bumper or to bumper mounting brackets;

No noticeable damage to front suspension, but both tires flattened (left front had been removed by wrecker crew);

Front of body distorted about 1 foot to the right; frame distorted about 3 inches to right;

Left front door jammed forward and inward at the hinge area, and door glass shattered;

Left A-pillar distorted inward and rearward less than 1 inch at the lower end; lower left of windshield fragmented and partially broken out; a 4-inch piece of glass, with portion of a yellow windshield sticker, was observed at the bottom of the inside of the left front door;

Figure 7: Front of 1961 Chevrolet Impala Sedan. Note rearward distortion at left front and relatively slight distortion to bumper. Two large dents in bumper at left (in photo), near bumper guard.

No evidence of impact damage rearward of left-front door, on the rear, or on the right side rearward of the right-front fender;

Steering wheel showed no damage and was not distorted; and

Yellow paint smears evident in numerous places throughout the front, left-front fender, and left-front door edge.

In addition to impact damage, fire damage was noted, as follows:

Engine components--wiring, plastic and soft-metal parts--burned away;

Paint burned and blistered throughout front and left side of the body;

Center area of windshield heat shattered and fragmented, with damaged portions missing (could not find Virginia inspection sticker);

Interior of vehicle--seats, door-panels, headliner--fire gutted but not burned away;

Rear window heat shattered and completely fragmented and missing;

The rear and right sides of this vehicle were not damaged, although rearward displacement of the right-front fender had partly jammed the right front door. This 1961 automobile was not equipped with seatbelts.

D. The Drivers:

1. The schoolbus driver, female, aged 22, had been driving schoolbuses about 1 1/2 years, was duly licensed and had no recorded traffic violations. This schoolbus was assigned to her, and she kept it parked overnight at her home. She knew of the seatbelts mounted at the driver's seat but said she personally disliked seatbelts and never used them. To the best of her knowledge, no order had been issued prior to this accident to use seatbelts, and "most" of the other schoolbus drivers shared her nonuse of seatbelts.

She said she was going about 25 m.p.h. just before the crash, and had seen the sedan approaching on Soapstone Drive, but assumed it was going to stop, as required. She could not estimate the sedan's speed.

She said she was thrown from the driver's seat in the original impact, and lost control of the bus. When it stopped moving it was off the roadway, headed up the left (south) embankment off Lawyers Road and tilted to its right. Her first thought was for the safety of the children, and she called to each one by name. Getting satisfactory responses, she then started toward the rear exit but was interrupted when the bus supervisor came through the driver's window and initiated rescue of the children via the bus windshield, which he had knocked out.

2. The sedan driver, male, aged 29, was duly licensed in Virginia; he had three traffic violation convictions, as follows:

6/10/65 Temporary License Plate Violation
8/24/67 Highway Signal Violation
3/28/68 Speeding Violation

Because of the severity of his injuries, the sedan driver could not be interviewed prior to the submission of this report. His injuries were informally reported as second- and third-degree burns over 30 percent of his body, minor facial cuts, and numerous contusions about the upper part of his body.

E. Other Pertinent Facts:

The question of whether schoolbus drivers shall use seatbelts is, at present, an issue which is determined by each autonomous school district or county. As yet there are no specific State or Federal requirements to install seatbelts in the driver's seat of existing schoolbuses; such requirements exist for new schoolbuses under the Federal Motor Vehicle Safety Standards (FMVSS). Under Motor Carrier Safety Regulations (Federal Highway Administration) all carriers--trucks and buses--in interstate commerce are required to have drivers' seatbelts and drivers are required to use them. The arguments presented for this requirement relate to the safety of bus passengers and of other highway users rather than as primarily for the safety of the driver.

The fact that Fairfax County installed driver seatbelts in all its schoolbuses in 1966 implies that the use of such seatbelts was intended. All drivers were encouraged to wear them, and their training programs stressed the importance of seatbelt use. However, no direct order (or regulation) was issued requiring schoolbus drivers to use them. Individual drivers said it was a matter of personal and individual choice.

The location of fuel tanks in schoolbuses is not specified in any FMVSS, and the "safest" or "best" location for such tank has not been established by any Federal agency. National Education Association (NEA) standard specifications suggest that the best position is on the right side, directly behind the service door. Truck manufacturers who make schoolbus chassis units have advised that the tanks are located in that position because of the NEA specifications, which have never been superseded, although some manufacturers do not agree that this is the safest location (see Figure 8, 9).

Management officials at the Fairfax County Garage indicated that they would prefer the tanks to be in some other location, either far to the rear on the right side, or about amidship on the left side. They argue that the spillage of fuel, especially on warm days with full tanks, creates an unnecessary hazard by being directly adjacent to the service door; students might discard cigarettes just before boarding, with the risk of igniting spilled fuel. A Fairfax County schoolbus was destroyed in such an incident in 1968, fortunately without injury to occupants or bystanders.

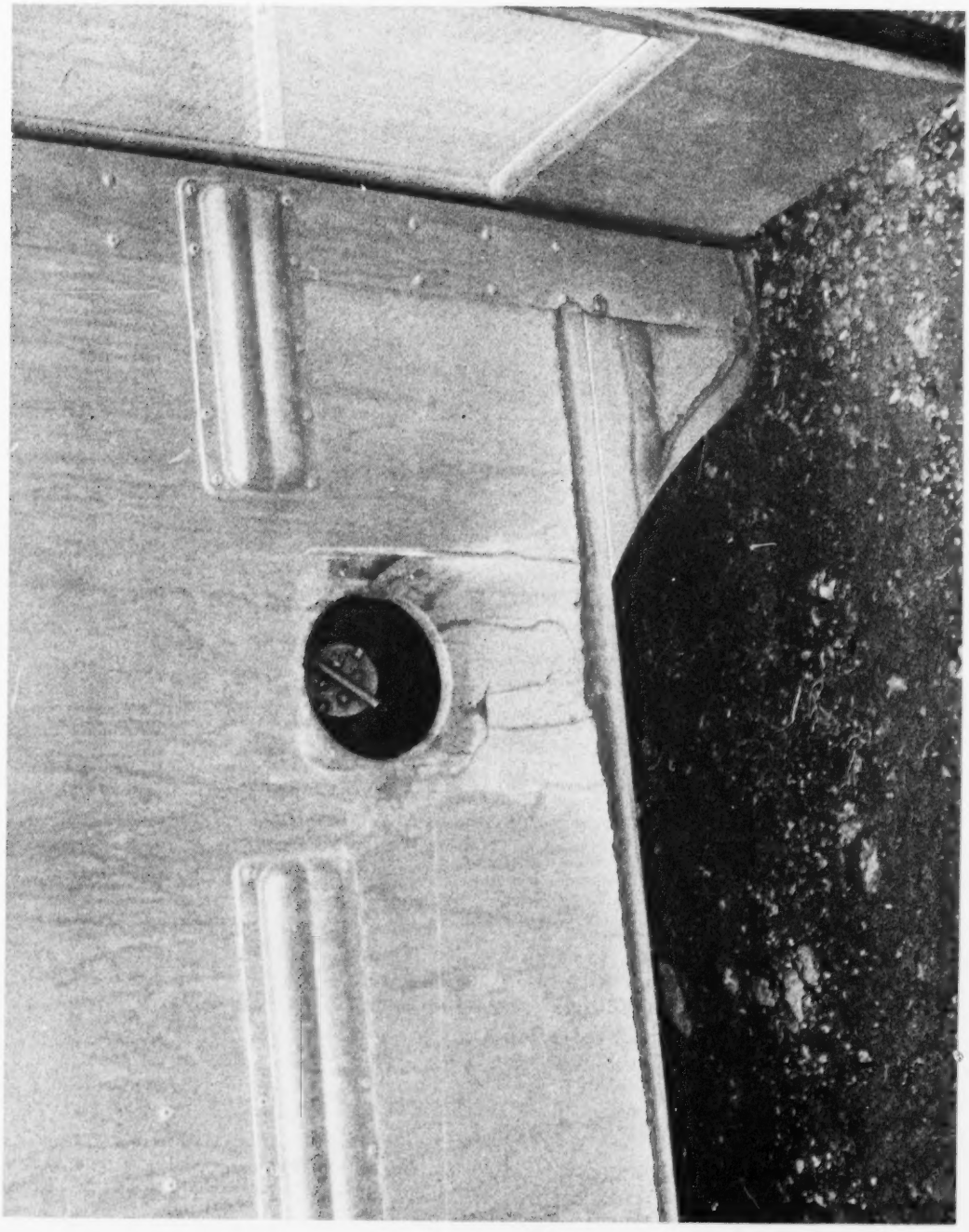


Figure 8: Universal location of schoolbus fuel-tank filler spout, shown on a bus body of other manufacture.

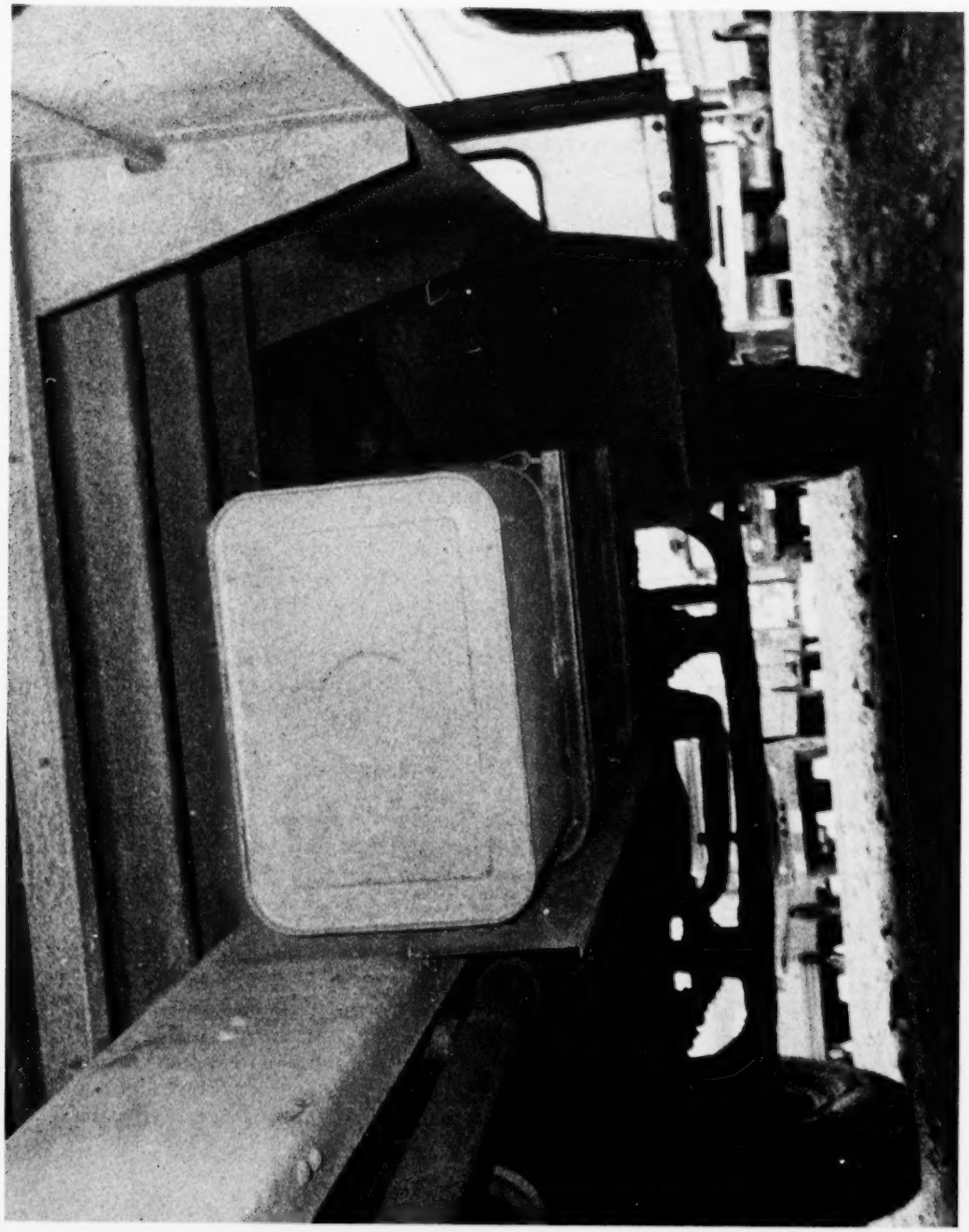


Figure 9: Location of schoolbus fuel tank. Heat shield at rear wall of tank was not present in the accident-involved bus.

Chassis manufacturers have advised that the cost of relocating the tank on new buses would be negligible, and would probably not increase the cost of the chassis to the buyer.

The service doors in the schoolbus involved in this crash were interlinked to open the forward half outward and the rearward half inward. An approximate count of Fairfax County schoolbuses showed that all of the newer buses (some 300 of the 680 buses in operation) employ this mode of door opening. Of the older models, some 300 are equipped with doors of which both halves swing outward, and the remainder have "accordion" or "jackknife" folding doors which move forward and are hinged inward at the middle.

A schoolbus operations executive said that the reason for the inward/outward hinging mode is that this offers less risk of striking students who might crowd around the door waiting to board, and that students crowding the door to exit cannot accidentally (or by intent) push the doors outward. No records were available to support these contentions.

NEA "standard specifications" leave the mode of door opening entirely to the purchaser. There are no FMVSS on the subject of schoolbus doors.

Five major schoolbus body manufacturers were informally polled regarding the mode of door opening supplied on their schoolbuses, with the following results:

WAYNE features the "jackknife" or "accordion" type opening, but will supply any other mode of opening requested by the customer; WARD, BLUEBIRD and SUPERIOR feature the split type, front-half out, rear-half in, but will supply other modes if specified; THOMAS features the split door with both halves swinging outward, but will optionally supply other modes. All modes of door opening are supplied without additional charge. While production figures for the various door types were not readily available, it would appear that some three out of five (60 percent) of schoolbuses sold nationwide are equipped with the inward/outward opening service doors (see Figure 10), with the balance roughly divided between the "accordion" and the double-outward types.

Public gathering places, such as theaters, restaurants, hotels, and schools, are all required by law to have doors which open outward. In a major streetcar/truck collision in Chicago, in 1950, it was found that the failure of the streetcar to have outward-opening doors was directly the cause of 32 (of a total of 34) deaths in the fire which swept through the streetcar following the crash. Since then, all new Chicago Transit vehicles have had outward-opening doors.

Figure 10: Split-type door, front half swing outward, and rear half swinging inward (photo taken inside a sister bus).

III. ANALYSIS

A. Crash Kinematics:

Skidmarks of the sedan showed that it did not stop before entering the intersection. The extent of crash damage to the sedan indicated an impact speed of about 20 to 25 m.p.h.

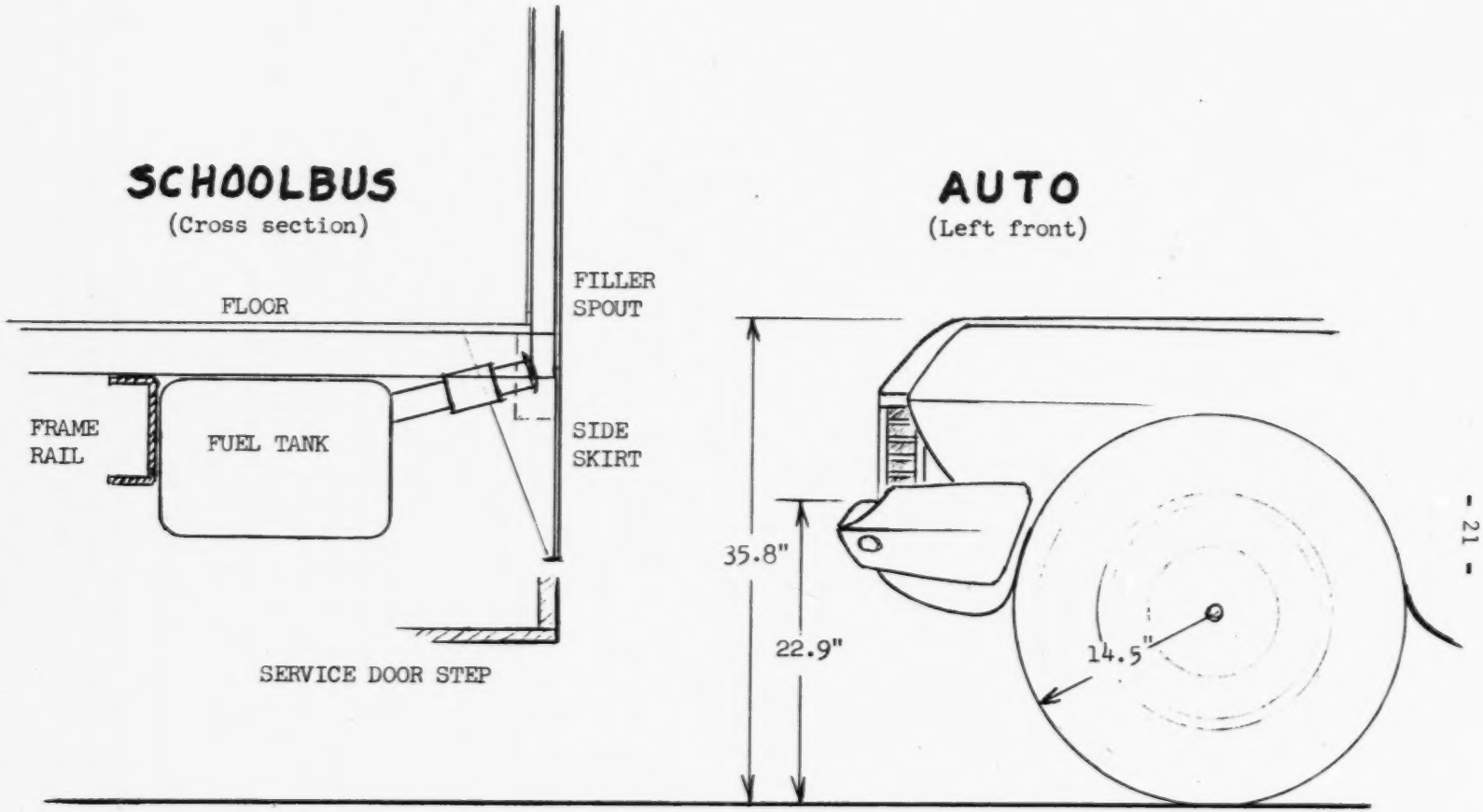
The absence of skidmarks of the schoolbus suggest that the driver was unaware that a crash was about to occur. The absence of bus tire marks after the crash support the driver's statement that she was thrown from her seat in the impact and the bus traveled out of control. The schoolbus speed as estimated by the driver was about 25 m.p.h.; it would have decelerated somewhat in traveling to where it ran off the roadway (approximately 140 feet). Damage to the bus suggests an impact speed of about 15 to 20 m.p.h. at the embankment.

The sedan struck the schoolbus at the bottom of the service doors, then the vertical bulkhead aft of the doorstep (which produced the two bumper dents), then crushed in the body skirt at the point of the gas tank. The bumper passed beneath the skirt and tank, but inward crushing of the skirt and tank, some 20 inches, was distributed across the frontal sheetmetal of the sedan, with the principal force on the left side (see Figures 7, 11).

When the schoolbus fuel tank was crushed inward at the rear the seam opened up and fuel began immediately to pour out; the rear tank-support bracket (and strap) failed. A fulcrum was provided by the tank body, overstressing the front tank bracket and retaining strap, which also failed, permitting the tank to drop away. As the tank traveled rearward (in relation to the forward motion of the bus) it scraped the frame rail and the fuel-line connection fitting was torn out of the tank. The momentum of the tank carried it in a direction roughly paralleling the path of the sedan after the impact (see Figure 1).

At impact, the sedan decelerated and was rotated severely clockwise, then accelerated westward along Lawyers Road. The unbelted driver was thrown hard to his left, against the door. Distortion of the front of the sedan to the right permitted the driver's door to open and the driver to fall out. The door swung open sufficiently to engage the side of the bus, compressing the door inward and distorting the door structure at the hinge area, as found. Before disengaging from the schoolbus, the sedan scraped along the bus, distorting the skirt area rearward and inward.

When the schcolbus impacted the embankment, the front axle and spring assembly were torn off. The bus then slid or bounced to its right, in a slightly counterclockwise rotation, overturned onto its right side, then rebounded upright as it settled to rest. During this movement, in addition



SCALE: Approx. 1 inch = 1 foot

Figure 11: Sketch showing relative heights of schoolbus and automobile components in the area where impact occurred. Dimensions are "at rest;" during severe braking, front end of automobile dipped downward so that bumper passed entirely beneath the bus fuel tank.

to the front end damage, there was additional da age to the right side, from the front fender area extending rearward. In this sequence, the service door was further crushed inward and the doorstep torn away, although it is apparent from the horizontal scoring that some inward distortion of both doors had been caused by the initial impact of the sedan's front bumper.

The schoolbus stopped with its rear end just off the pavement, some 155 feet west of the intersection, at an angle of about 45° to the roadway, its front end up the embankment, and tilted partially to its right, with the service door jammed into the embankment. Because of the bending and jamming, the service door was totally inoperable. Damage to the right rear corner and window was done by contact with the roadway in the overturn. The broken glass was found 159 feet from the intersection, at the pavement edge. No other windows were damaged in the collision events. Separation of the drive shaft probably occurred in the sideward slidings and bouncing.

Rupturing of the schoolbus tank rear headwall seam in the initial crash caused a substantial stream of gasoline to be dumped from the point of impact to some 85 feet to the west. It could not be determined at what point ignition took place, but there were at least three likely sources of ignition during the impact event: (1) heat and sparks from the impact crushing damage, (2) electrical energy released from the battery or cables, (3) friction heating and sparks from the scraping of metal components along the roadway immediately after impact. Any one or any combination of these could have ignited the gasoline.

If the impact speed of the sedan had been slightly less, it is not inconceivable that the schoolbus fuel tank would still have ruptured, but might not have separated from the bus. Under those conditions, the fire would then have followed the trail of gasoline to the bus, and engulfed the area around the service door and driver's compartment as the bus was lying tilted upward and to its right. In this event, entry by the bus supervisor (through the driver's window) might have been prevented by the fire and fumes; also, the busdriver would probably have been totally incapacitated. A large-scale tragedy could easily have followed. Speculation as to such tragic results cannot be brushed aside. The scene was set. It should not be necessary to wait until such a tragedy has in fact occurred to appreciate how closely this event missed becoming such an example, and to remove the elements which brought it to the brink.

B. Use of Seatbelts by Schoolbus Drivers:

The one overriding argument for requiring seatbelts to be used by drivers of public conveyances is that seatbelts will make a significant difference in keeping drivers in their seats during (typical) collisions, skids,

evasive actions and near upsets. Belted to their seats, drivers would thus be in a better position to keep the vehicle under control, to prevent its crashing into other vehicles or running off the roadway. This is the logic behind the Motor Carrier Safety Regulation which requires interstate-carrier drivers to use seatbelts. This accident is an excellent illustration of this logic. If the schoolbus driver had been wearing her available seatbelts, it is almost certain that she would have been kept in her seat and thus able to bring the bus to a stop on the roadway..

All occupants of the schoolbus were injured in the second collision of the bus (on the embankment) and in its upset. These injuries would not have been incurred if the driver had been able to maintain control. The obligation on the part of the drivers of public conveyances (interstate or local) to protect the safety of their passengers should transcend drivers' individual preferences or prejudices regarding the wearing of restraints for their own personal safety.

While the authority to require installation of seat restraints in newly manufactured schoolbuses is within the authority of NHTSA, the use of such seatbelts is not. A requirement for schoolbus drivers to use seat restraints had been incorporated into the intended pupil-transportation standard (Highway Safety Program Standard No. 17) which was not approved by Congressional action in December, 1971. Pending the reestablishment of such a program in the proposed revision and consolidation of program standards, all States can act without delay to require the use of seatbelts (or other currently approved or required restraints) by schoolbus drivers. Individual counties or school boards are not prevented from enacting their own similar requirements as interim measures pending any State action or the revision of the Federal Highway Safety Program Standards.

C. The Location of Schoolbus Fuel Tanks:

It seems almost self-evident that, in its present location, and without additional crash protection, the schoolbus fuel tank presents a real and an unnecessary hazard. For example, a moderate side impact and underride by a passenger car can simultaneously render the service door inoperative and rupture the fuel tank. Gasoline under those conditions, as illustrated by this accident, has many potential sources of ignition. If the service door glass is broken, a fuel-tank fire or super-heated fumes could be sucked into the bus via the damaged door, aided by normal convection currents induced by the air within the bus which is warmer than ambient outside air, as well as by any forward motion of the bus.

Located in almost any other place, the fuel tank would be far less vulnerable to damage in the same collision which might damage either the service door or the emergency exit. Since schoolbus windows are rarely broken in ordinary collisions, there should be no ready entry for flames or fumes, and

a fuel-tank fire should not deny students the full use of both the service door and the emergency exit. Evacuation of students could thus be accomplished in less time and with greater safety.

Apart from relocating the fuel tank, but importantly related, would be the addition of crash-resistant outboard frame members, or some other form of crash-guard design, to enhance the resistance of the fuel tank to damage in ordinary crashes. For example, in the accident under study, the vertical rear bulkhead at the entranceway acted as a crash-protection device for the tank, so that the front end of the tank was not struck by the underriding sedan. However, because the sedan rotated while the vehicles were in engagement, the left front of the sedan penetrated the body skirt and crushed the bus fuel tank. The provision of crash guards would add moderately to the chassis cost.

In the absence of FMVSS or State regulations on this issue, local school boards or counties can specify other locations for fuel tanks for all new buses, probably without additional unforeseen cost. What is really needed, however, is NHTSA (or VESC) study and rulemaking to specify the safest and best location for such fuel tanks.

It has been argued that the location of the fuel tank on the left side would expose it to more numerous (and greater) hazards than locating it on the right side. It has been the experience of Fairfax County that the vast majority of schoolbus collisions (with vehicles or with fixed objects) have occurred on the right sides of schoolbuses, due, they say, to the peculiarities of schoolbus operations; oncoming or overtaking traffic may not be the direct hazard that it is argued theoretically to be.

D. Opening Mode of Schoolbus Service Doors:

The argument for outward-opening doors on schoolbuses should not meet with serious rebuttal. Yet, in view of the apparent preponderance of choice of the outward/inward swinging doors it is apparent that strong argument is needed to establish a case for outward-swinging doors. To determine which mode of opening, safest from most operational standpoints, is the best, should not be too difficult to ascertain by testing and by studies of accident reports, aided by computer technology. Standards for such opening mode should be incorporated into the FMVSS.

For example, with outward-swinging doors on all schoolbuses, which are alleged to endanger students both entering and exiting, students would learn quickly not to crowd the entrance. To prevent accidental opening of doors by students crowding to get out, a trigger-release safety could be incorporated into the door opening mechanism. Prototypes for such mechanism are already available. In a panic situation, as in a major crash or a fire, the instinctive crowding and pushing on exits has been demonstrated to occur, as in the Chicago streetcar fire, despite passengers' knowledge that the doors normally did not hinge outward.

E. Persons Affected by Schoolbus Safety Issues:

In the Safety Board's Special Study (NTSB-HSS-70-2) titled: Inadequate Structural Assembly of Schoolbus Bodies (issued in August, 1970), the Safety Board pointed out the injustice and unfairness of allowing correctable sources of injury to continue, in that the children were essentially involuntary passengers, and further, that the schoolbus type of construction is widely used by military agencies, small bus lines, and for many local and charter services.

The Board reiterates these points. In the case of the safety issues addressed in this report, the correction of all three problems can be accomplished at little or no cost to the school districts or counties which purchase and use the buses. In this accident, five schoolbus occupants were slightly injured. A very minor difference in circumstances could easily have resulted in five fatalities. On a purely economic basis, the cost effectiveness of making these changes would appear to allow little room for counter argument.

IV. CONCLUSIONS

1. The roadway, weather, visibility limitations, or possible adverse vehicle condition did not contribute to causation of this accident.

2. Both vehicles were approaching the intersection at about 25 miles per hour immediately before the collision.

3. The sedan failed to stop before entering the intersection; its brakes were applied only 12 feet before impact.

4. The schoolbus driver could not know that the sedan would fail to stop, as the sedan driver could have seen the approaching schoolbus about 100 feet from the intersection.

5. Nonuse of available seatbelts by the schoolbus driver prevented the driver from regaining control of the bus, which resulted in its running off the roadway and its partial overturn on the south embankment of Lawyers Road.

6. Penetration of the schoolbus side skirt did not require an unusual amount of kinetic energy; the damage to the bus fuel tank and subsequent loss of fuel would probably have occurred even if the sedan had been going considerably slower at impact than it was.

7. The location and absence of structural protection of the schoolbus fuel tank contributed to its rupture and its separation from the bus.

8. Under current schoolbus design, it is possible for an automobile to strike the right side of a schoolbus in a single collision which can simultaneously disable the service door and cause a fuel-tank fire.

9. It was extremely fortunate for the schoolbus occupants that the bus fuel tank separated completely from the bus; if the tank had remained with the bus, a tragic conflagration would probably have ensued.

10. Ignition of the spilled gasoline was almost simultaneous with the initial impact, but the exact source of ignition cannot be identified from among three potential and available sources.

11. The driver of the sedan was ejected immediately after impact into the area where spilled gasoline was afire.

12. The schoolbus service doors were partially damaged, and possibly disabled, in the initial impact; however, they were subsequently totally jammed and disabled by impact with the embankment.

13. Some 60 percent (or more) of all schoolbuses in current production are equipped with split service doors, with the forward half opening outward and the rear half opening inward; such opening mode has not been established as the safest and best mode of opening.

14. It should be feasible to determine which door-opening mode, of several available, is the safest overall mode for schoolbus use.

15. The safer location of the fuel tank and the use of outward-hinging doors (or other most-safe mode of opening) should not adversely affect the costs of schoolbus construction.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this collision was the failure of the driver of the sedan to yield right-of-way at a stop sign. Fire was caused by an undetermined source of ignition of gasoline from the ruptured and detached schoolbus fuel tank, contributed to by the vulnerable location of the fuel tank and the absence of crash-protection design features. Injuries to the sedan driver were caused by impact with internal components of the sedan, by ejection onto the roadway, and by exposure to flames from the burning gasoline.

The second collision of the bus, into the embankment, was caused by loss of driver control. The nonuse of available seatbelts by the driver prevented the regaining of control. The injuries to the bus occupants were caused by impact against interior bus components in the second collision and partial overturn.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. All States enact requirements for school districts or administrations within their jurisdiction, through State funding assistance or any other appropriate authority, for the installation of suitable restraint systems (seatbelts or other approved devices) at the driver's position in all schoolbuses, and for the wearing of such restraints (or the use of such devices) at all times when persons are being transported in such schoolbuses.

2. The National Highway Traffic Safety Administration and the Vehicle Equipment Safety Commission, in consideration of the unnecessary hazards posed by locating schoolbus fuel tanks adjacent to service doors, act promptly to determine the "best" and "safest" location for schoolbus fuel tanks and to specify such location, as well as any protective shield or structural changes, to minimize the likelihood that a collision which might disable the service door or the emergency exit will also initiate a schoolbus fuel tank fire, and vice versa.

3. The National Highway Traffic Safety Administration and the Vehicle Equipment Safety Commission, in consideration of hazards posed by schoolbus service doors which open in such fashion that the pressure of persons from within the bus might hamper or prevent the expeditious opening of such doors in an emergency, act promptly to determine the safest mode of service-door opening and to specify such mode of opening in appropriate standards.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

April 12, 1972